and circular elements are accordingly used in the formation of tables for the prediction of the positions of the satellite. For the epoch 1873, December 31, Washington mean noon, the mean longitude of the satellite, reckoned from the intersection of the orbit with the plane parallel to the earth's equator, and passing through the centre of the planet, was 98°·96; the node on equator, 183°·03, and the inclination, 121°·7. The radius of the orbit at the mean distance of Neptune [1·47814] is found to be 16″·275, or 218,550 miles. The mean motion assumed at the commencement of the discussion was that founded upon the observations of Mr. Lassell (Hind, "Monthly Notices," vol. xv.), and does not appear to admit of any sensible correction. Prof. Newcomb thinks the motion of mean longitude is correct within 2° or 3° a century. The period of revolution of the satellite is 5·8769 days.

No trace of a second satellite of Neptune has ever been seen, though it has been looked for carefully on several occasions.

The conclusion to which Prof. Newcomb's investigations have led, "that the orbits of all the satellites of the two outer planets are less excentric than those of the planets of our system, and that, so far as observations have yet shown, they may be perfect circles," will appear a remarkable one.

We take this opportunity of presenting the elements of the orbits of Uranus and Neptune adopted in the Tables of Prof. Newcomb, as perhaps an acceptable addition to the preceding outline of his researches on the satellites of these planets. The values of the major axes here given are not those which would result from the mean motion with correction for the mass, but in the case of Uranus include a constant term in the perturbations of the radius vector, and in that of Neptune, constants introduced by the action of the planets, and effect of secular variation of the longitude of the epoch :—

	Uranus.	Neptune.
Mean longitude, 1850 Jan. 0·0 G.M.T.	28° 25′ 17″·1	335° 5′ 38″·9
Longitude of perihelion	168 15 6·7	43 17 30·3
Ascending node	73 14 8·0	130 7 31·9
Inclination	0 46 20·5	1 47 0·6
Excentricity	0·0469236	0·0084962
Mean motion in the Julian year	15425″·75	7864″·935
Semi-axis major	19·19130	30·07055
Period in days	30686·63	60186·64

CASSOWARIES

LIKE the minor planets, Cassowaries are of late years continually increasing in number. A short time ago there was but one "Cassowary" recognised by naturalists, which was vaguely stated to inhabit "the Moluccas." Even Mr. Wallace's extensive researches in the Indian Archipelago only resulted in ascertaining the exact island to which the original *Casuarius galeatus* is restricted, without making us acquainted with other species. But recent expeditions into the less known parts of the Papuan sub-region have led to a much more extended knowledge of the subject, and we have now arrived at the conclusion that the genus *Casuarius* embraces a numerous group of species, each of which has special distinctive characters and a peculiar geographical distribution. Six of these forms of Cassowary are at the present time represented by specimens living in the Gardens of the Zoological Society of London, where they have attracted much attention. It is with the hope of obtaining further exact information concerning these fine birds from travellers in the countries which they inhabit that I have drawn up the following short summary of the present state of our knowledge of the different species.

The Cassowaries may be divided into three sections, as shown in the subjoined table :—

Table of Species of the Genus Casuarius.

a. Casside lateraliter compressa; appendicula cervicis aut duplici aut divisa.

1. *C. galeatus*, ex ins. Ceram.
2. *C. beccarii*, ex ins. Aroensi Wokan.
3. *C. australis*, ex Australia bor.
4. *C. bicarunculatus*, ex ins. Aroensibus.

b. Casside transversim compressa; appendicula cervicis unica.

5. *C. uniappendiculatus*, ex Papua.

c. Casside transversim compressa; appendicula cervicis nulla.

6. *C. papuanus*, ex Papua boreali.
7. *C. westermanni*, ex ins. Papuana Jobie (?).
8. *C. picticollis*, ex Papua meridionali.
9. *C. bennetti*, ex Nov. Britann.

The first of these sections contains the large species allied to the original *C. galeatus*. These have on their heads an elevated casque, laterally compressed and terminating in a ridge in the same line as the culmen of the bill. They have also a large fleshy caruncle on the front of the neck, ending in two distinct flaps. A single species, which stands somewhat alone and forms a second section, is also of large size, but has the casque transversely compressed and ending in a ridge at a right angle to the culmen. It has but one medial throat-wattle, whence it has been named *uniappendiculatus*. The third section embraces the smaller species allied to Bennett's Cassowary, or the Mooruk. These have the casque transversely compressed as in the one-wattled species, but have no wattle on the throat—only a bare, brightly coloured space. They are further distinguishable by the extraordinary form of the claw of the inner toe, which attains a remarkable length and is used as a weapon of attack. Of these three sections, the following nine species are now known with more or less certainty :—

1. THE COMMON CASSOWARY (*G. galeatus*), of which there is now no doubt that the island of Ceram is the true habitat. Of this species we have now one example, not yet adult, in the Zoological Society's Gardens.

2. BECCARI'S CASSOWARY (*C. beccarii*).—This form is closely allied to *C. galeatus*, but is easily distinguishable from it by having only one medial throat-wattle, which is slightly divided at the extremity. It has a large elevated casque like the Australian Cassowary, and remarkably large strong legs. The species was originally described by me from a specimen in the Museo Civico at Genoa, which was brought by Beccari from the Aroe Islands; but the living individual now in the Zoological Gardens (if it is really of the same species) was obtained in the south of New Guinea by H.M.S. *Basilisk*.

3. THE AUSTRALIAN CASSOWARY (*C. australis*).—Of this Cassowary, remarkable in the adult for its large size and highly elevated casque, we have now two specimens living in the Gardens. It is a native of Northern Queensland and the peninsula of Cape York.

4. THE TWO-WATTLED CASSOWARY (*C. bicarunculatus*).—This species, which is easily known, even in the young condition, by having the wattles separated and placed far apart on the sides of the neck, was first described from two examples, formerly living in the Zoological Gardens, but now dead. There are several stuffed specimens of it in the Leyden Museum, which were undoubtedly obtained in the Aroe Islands.

5. THE ONE-WATTLED CASSOWARY (*C. uniappendiculatus*).—The single small wattle which ornaments the middle of the neck at once distinguishes this fine species, of which we have now in the Gardens a young specimen brought by H.M.S. *Basilisk* from the coast on the north of New Guinea, opposite Salawatty. There is a good figure of this Cassowary in the supplement to Gould's "Birds of Australia."

6. THE PAPUAN CASSOWARY (*C. papuanus*).—This name has been given to two specimens in the Leyden Museum, obtained near Dorey, in New Guinea, by Rosen-

berg. Prof. Schlegel at first identified them with the Mooruk, but afterwards admitted their distinctness. My belief is that they are probably the same as the next species (*C. westermanni*), although the colours of the neck, as restored in the stuffed specimens, do not quite agree.

7. WESTERMAN'S CASSOWARY (*C. westermanni*).—This species I established on a bird still living in the Zoological Gardens, which we received from Mr. Westerman in 1871. At first I referred this bird to *C. kaupi*, of Rosenberg, until that naturalist showed that the pretended species which he had so named was nothing more than the young of *C. uniappendiculatus*. I then changed our bird's name to *C. westermanni*. I have recently seen two other living specimens of this bird in the Zoological Gardens at Rotterdam. It has been suggested that its true home is the island of Jobie, in the Bay of Geelvink, where Dr. Meyer ascertained the existence of a Cassowary, but was not able to procure specimens.

8. THE PAINTED-NECKED CASSOWARY (*C. picticollis*).—This species was likewise established by me on a specimen now living in the Zoological Gardens, which was obtained by the officers of H.M.S. *Basilisk* at Discovery Bay, on the east coast of New Guinea. It greatly resembles the Mooruk, but differs in its brilliantly-coloured neck, of which I have given a drawing in the P. Z. S. for the present year (1875, Part I.)

9. THE MOORUK, OR BENNETT'S CASSOWARY (*C. bennetti*).—In 1857 Mr. Gould described this Cassowary from a drawing sent to him by Dr. George Bennett, of Sydney, and soon afterwards a living pair were sent to us by our excellent friend, after whom the species had been named. These birds bred in the Gardens in 1864, but we have now unfortunately lost them. Bennett's Cassowary is an inhabitant of New Britain, to the east of New Guinea, and is easily distinguishable from its congeners by its blue throat and back of the neck.

Omitting for the moment the doubtful *C. papuanus*, it will be thus seen that we have tolerably certain indications of the districts in which the other eight Cassowaries are found. It would be very desirable, however, to get further information concerning them, and also to ascertain what is the Cassowary of Jobie, and whether the other islands adjacent to New Britain possess, as is probable, indigenous species of this group.

P. L. SCLATER

ANOTHER MONSTER REFRACTOR

THE experiment rendered possible, now some ten years ago, by Mr. Newall, and made with such triumphant success by Mr. Cooke, is again bearing fruit. Another monster telescope, indeed the largest yet attempted, is now in course of construction at Mr. Grubb's new works, near Dublin. This instrument has been ordered by the Imperial and Royal Austro-Hungarian Government for the new Observatory now in course of erection at Vienna. The object-glass will have an aperture of over 26 inches, probably about 27 inches, according as the discs of glass, which are being manufactured in the rough, by M. Feil, of Paris, may turn out on finishing. The focal length is to be about 32 feet. The general form of mounting will be modified to suit the special requirements of such a monster instrument. The great base casting (weighing some seven to eight tons) will form a chamber (about 12 feet long, 4 feet 6 inches wide, and 8 feet high) for the clock, which will be massive in proportion to the other parts. The axes will all have their friction relieved by anti-friction apparatus. The tube will be entirely of steel, and all the various motions of the instrument, as well as the reading of the different circles, will be available to the observer from the eye-end of the telescope.

A circular chamber of 45 feet diameter has been provided in Mr. Grubb's new workshops, to be covered for the present by a corrugated iron roof 50 feet high. In this the telescope is to be set up, and over this will be meanwhile erected an enormous steel dome, revolving on the system of rollers designed some years since by Mr. Thomas Grubb, and adopted at Dunsink Observatory, near Dublin, and at Lord Lindsay's Observatory. All of this dome and revolving machinery is afterwards to be removed to Vienna. Thus, by taking down the stationary iron roof, when the steel dome is erected over it, the equatorial will be placed in perfect working order, under its own roof in Dublin, for trial. It is proposed to attempt to illuminate the verniers and circles by Geissler's tubes. If M. Feil can, as he hopes, perfect the pair of discs required within twelve months, Mr. Grubb expects to have the whole instrument complete by the autumn of 1878, in which year, we may remark, it is not impossible that the British Association may be invited to Dublin. Should Lord Rosse's reflector be in order and the Vienna telescope complete, Section A will certainly muster in great force.

THE DIFFERENCE OF THERMAL ENERGY TRANSMITTED TO THE EARTH BY RADIATION FROM DIFFERENT PARTS OF THE SOLAR SURFACE

PÈRE SECCHI, in the second edition of "Le Soleil," published at Paris 1875, again calls attention to the result of his early investigations of the force of radiation emanating from different regions of the sun's surface, reiterating without modification his former opinions regarding the absorption of the radiant heat by the solar atmosphere. It will be well to bear in mind that the plan adopted by the Italian physicist in his original researches, on which his present opinion is based, was that of projecting the sun's image on a screen, and then, by means of thermopiles, measuring the temperature at different points. The serious defects inseparable from this method of measuring the intensity of the radiant heat I need not point out, nor will it be necessary to urge that a correct determination of the energy transmitted calls for direct observation of the temperature produced by the rays projected towards the earth. Accordingly, on taking up that branch of my investigations of radiant heat which relates to the difference of intensity transmitted from different parts of the sun's surface, I adopted the method of *direct* observation. The progress was slow at the beginning, owing to the necessity of constructing an astronomical apparatus of unusual dimensions, but having devised means which rendered the employment of any desirable focal length practicable, the work has progressed rapidly. An instrument of 17·7 metres (58 feet) focal length, erected to conduct preliminary experiments, has proved so satisfactory that the construction of one of 30 metres focal length, which I supposed to be necessary, has been dispensed with. Considering that the apparent diameter of the sun at a distance of 17·7 metres from the observer's eye is 162·4 millimetres even when the earth is in aphelion, the efficacy of the instrument employed might have been anticipated. The nature of the device will be readily comprehended by the following explanation:—Suppose a telescopic tube 17·7 metres long, 1 metre in diameter, devoid of object-glass and lenses, and mounted equatorially, to be closed at both ends by metallic plates or diaphragms, at right angles to the telescopic axis. Suppose the diaphragm at the upper end to be perforated with two circular apertures 200 millimetres in diameter, situated one above the other in the vertical line, 360 millimetres from centre to centre; and suppose a third circular perforation whose area is one-fifth of the apparent area of the solar disc, viz. 72·6 millimetres diameter, to be made on either side of the vertical line. Suppose, lastly, that the diaphragm which closes the lower end of the tube be perforated with three small apertures 6 millimetres in diameter, whose centres correspond exactly with the centres of the three large perforations in the upper diaphragm. The tube being then directed towards the sun, and actinometers applied below the three small apertures in the lower diaphragm, it will be evident that two of these instruments will, after due exposure to a clear sun, indicate maximum solar intensity, say 35° C., while the actinometer applied in line with the perforation whose area is one-fifth of the apparent area of the solar disc, will indicate $\frac{35}{5} = 7°$ C., unless the central portion of the solar